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MICROSCOPICAL PETROGRAPHY

Microscopical Petrography. By Ferdinand Zirkel. Being Vol. VI. of the Report of the United States Geological Exploration of the Fortieth Parallel made under the direction of the Engineer Department by Clarence King, Geologist-in-charge. (Washington, 1876.)

TO the massive and important series of volumes in which the Report of the Exploration of the Fortieth Parallel has been published the Engineer Department of the United States has just added a sixth which, for general interest and usefulness beyond the area of the Survey, is equal if not superior to any that has preceded it. In the course of this protracted and laborious survey many rocks were encountered to which Mr. Clarence King and his coadjutors felt somewhat at a loss to apply the petrographical nomenclature of Europe. He accordingly sought help from the highest European authority on the subject, Prof. Zirkel, of Leipzig, whom he induced to undertake the task of examining the vast collection of rock-specimens which had gathered during so many years of field-work. Prof. Zirkel accordingly crossed the Atlantic, spent some time in New York with Mr. King and his staff in making a preliminary investigation of the collection, and in learning the geological position of the specimens and the geological structure of the wide region from which they had been obtained. Subsequently a large and typical series of rock-specimens was sent over to Leipzig to be submitted to careful microscopical investigation. No fewer than twenty-five hundred thin sections were prepared and examined under the microscope. The result of Prof. Zirkel's laborious task is now given to the world and most appropriately forms a separate volume of the Report on the Geology of the Fortieth Parallel. Mr. King may be congratulated upon the judgment he has shown in the allocation of his materials. He has enriched his official publications with the most important contribution yet made to the petrography of America.

Of the way in which Prof. Zirkel has acquitted himself of the task he undertook, it is hardly possible to speak too highly. With the characteristic method of his countrymen he marshals his facts in such orderly fashion that every observation has its appropriate and proper place where it may be expected and where, if sought for, it will be found. Familiar as he is with the minute texture and composition of most European rocks, it must have been a congenial, even though laborious work, to attack on such a scale those of another continent. He has evidently given himself heartily to the investigation, and has produced a work which more than sustains his well-earned reputation.

In an introductory chapter the author briefly sketches the leading types of microscopic structure which, largely as a result of his own previous labours, have been recognised among crystalline rocks. These may be reduced to three:—1. The purely crystalline, that is, rocks which display only crystals or crystalline particles so interwoven as to form a solid, compact mass. Granite may be taken as the type of this group. 2. The half-crystalline. Rocks of this group consist partly of crystals or crystalline

particles, and partly of a non-crystalline amorphous substance or paste, which may be (a) a colourless but more usually yellow, brown, or grey glass; (b) partly devitrified by the appearance of minute translucent but non-polarizable grains (globulites), or variously-shaped opaque needles or hairs (trichites); (c) still further devitrified by the increase of these grains and needles, so that little or no glass remains—a structure termed micro-crystallitic; or (d) a peculiar amorphous substance neither showing the transparency of glass nor definite grains and needles (crystallites), but appearing to consist of indistinct grains or fibres, which seem to melt into each other. This is termed the microfelsitic. 3. The non-crystalline. Here the rocks consist sometimes merely of glass, as obsidian, sometimes of the amorphous microfelsitic substance, as in felsites. Dr. Zirkel admits, however, that even where these differences of minute structure are best shown they do not suffice as a basis for the systematic arrangement of rocks, which must rest on fundamental mineral constitution. The same mass of rock, indeed, may within a short space put on extraordinary diversities of minute structure.

A number of terms are introduced into the Report which, though most of them have for some time been in use in Germany, for the most part make their first appearance here in an English dress. "Ground mass" is employed to denote what seems to the naked eye to be the dense homogeneous matrix of a rock, wherein the usual scattered porphyritic crystals are held; "base" is used as the designation of what is only seen under the microscope to be a non-crystallised or unindividualised paste, glassy, globulitic, micro-crystallitic or micro-felsitic, as the case may be, in which the crystals, whether microscopic or visible to the naked eye, are held. "Macroscopic" has obtained wide currency in German petrographical literature as a convenient designation for what can be seen without the use of lenses. "Microlites" are minute, thin, needle-shaped, usually cylindrical bodies, which occur both in the base and in separate crystals of rocks, and represent imperfect stages in the crystallisation of different minerals; when colourless they are called "belonites," when black and opaque, "trichites."

As most rocks have undergone more or less internal alteration, many products of decomposition are met with under the microscope which cannot always be identified with definite mineral species. No one who has practically studied microscopic petrography can fail to have been often puzzled to name some of these products. They are in far too minute quantity and too intimately diffused through the substance of a rock to be capable of being collected for chemical analysis. They present no recognisable crystallographic form, and they show no distinctive reaction under the polariscope; yet they have too often, with no expression of hesitation, been identified with known minerals, the identifications being at the best only guesses, and sometimes most improbable ones. It has lately been the practice at Leipzig to avoid attempting such identifications when the evidence is so slight, but to be content with the application of provisional names which may include many different compounds having at least some common characters, such as opacity or colour, and to wait until the progress of investigation allows more precise names

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to be affixed. Prof. Zirkel now introduces these provisional and useful terms to English readers. "Opacite" includes all the black opaque amorphous grains, scales, and streaks which have resulted from the decomposition of different minerals, and which, no doubt, vary widely in chemical constitution. They probably in most cases consist largely of metallic oxides. "Ferrite" embraces those yellowish, brownish, or reddish specks, grains, veinings, or pseudomorphous crystals which occur in so many rocks where oxides of iron have decomposed. "Viridite" is the term applied to greenish transparent or translucent scales, fibres, or veins, frequently seen where hornblende, augite, or olivine have been altered. They must vary much in composition, sometimes approaching chlorite, sometimes delessite or serpentine.

These scientific terms may be usefully transplanted into English text-books. The only one which, though the great need of such a word cannot be denied, seems open to considerable objection, is "macroscopic." It is too like "microscopic," whether as written, printed, or spoken. "Gymnoscopic" would be better. But there occur throughout the Report many nouns and adjectives which the reader will in vain look for in any dictionary, and the meaning of some of which he will not readily appreciate if he does not happen to be familiar with the German petrographical terms for which they are intended. Such are "fibration," "lamellation," "inclusion," "zonality," "lineated," "fluidal," "interwedged," and many more. Even ordinary words are used in a way which is apt to puzzle the uninitiated. For example, "some occurrences are poor in augite," "poorly-shaped crystals," "drop-like or crippled minerals." The English language is not quite so meagre as to be unable to furnish expression in already familiar words and phrases to the ideas sought to be conveyed by these novel and sometimes rather uncouth terms.

After a brief chapter devoted to the crystalline schists and their related rocks, the author proceeds to what are commonly known as the igneous rocks, beginning with granite and the early intrusive porphyries and felsites, passing thence through the diorite, diabase, gabbro, and other groups, into the wide series of tertiary volcanic products. V. Richthofen's name propylite is retained for the oldest eruptive rock of the tertiary series—a mixture of plagioclase felspar with hornblende, having most of the characters of the old diorites and dioritic porphyries. The petrographical differences between this rock and andesite are carefully summed up by Prof. Zirkel; but at the most they appear to be rather fine-drawn. He insists that rocks of different geological date can be distinguished petrographically, and that this may be done even among the different members of the tertiary series. Undoubtedly the most important chapter of the Report is that devoted to the trachytic and rhyolitic rocks. Among the trachytes some have been found containing augite instead of hornblende—a curious and novel fact which establishes an analogy between these tertiary masses and some old syenites of Tyrol and Norway, in which G. von Rath has lately shown that augite replaces hornblende. The author partly following von Richthofen divides the rhyolites into (1) Nevadite or granitic rhyolite; (2) Rhyolite proper, including the felsitic and porphyritic varieties, of which he has found among

the rocks of the Fortieth Parallel no fewer than sixteen well-defined types; and (3) Hyaline rhyolite, including the glassy and half-glassy varieties, obsidian, pitchstone, pumice, &c. With the exception of some varieties in the eastern part of the region, all the basalts met with in the course of this survey prove to be felspar-basalts. Though repeating in Western America the familiar characters of the basalts of Western Europe they contain some varieties which merit a special subdivision. These are marked by (1) the invariable presence, though in small quantity, of sanidine, (2) the general absence of olivine, (3) the abundance of the glassy microlitic base, (4) the occasional presence of hornblende, (5) a high proportion of silica, (6) the dusty character of the included apatite. A petrographer who admits such wide departures from the normal type of a species must not be surprised at those who would further seek to unite some of his species which hardly differ from each other so much as these varieties of basalt do.

The Report is illustrated by twelve quarto coloured plates. For beauty of execution nothing has appeared like them since those of the lamented Vogelsang. They have been executed at Leipzig, under the author's own eye, and are evidently as faithful as they are vivid and artistic.

ARCHIBALD GEIKIE

OUR BOOK SHELF

Results of the Aralo-Caspian Expedition. Fascicule iv., 383 pp., with seven lithographed plates; and Fascicule v., sixty-eight pages. (St. Petersburg, 1877.) [Russian.]

THE fourth fascicule of this publication contains an important paper by the well-known Russian ichthyologist, Prof. Kessler, on "The Fishes of the Aralo-Caspian Pontic Ichthyological Region." After an introduction, in which the author briefly sketches the geography of the region, and makes a few objections to some statements of Mr. A. R. Wallace as to the geographical distribution of fishes, Prof. Kessler describes forty-three new species and varieties of fishes of the region, and twenty-four other species, the previous descriptions of which were incomplete. These descriptions, being the result of very elaborate researches, are based on extensive collections obtained by the members of the expedition, and by previous explorers. The new species are illustrated by seven plates. The second part of the work is a systematic catalogue of all fishes known to inhabit the region, with notes as to their geographical distribution.

The third part deals with the general conclusions arrived at by the author as to the geographical distribution of species, the relations of the Aralo-Caspian ichthyological fauna to the faunas of the neighbouring basins, the distribution of species in different waters of the region, the zoological characteristics of the fishes inhabiting it, and their genealogical relations, their mode of life, and some remarks on the geological history of the region. These conclusions (some of which have already been noticed in NATURE) will certainly be of great interest to the zoo-geographer, and their importance is much enhanced by the usual caution of M. Kessler's statements. The work is altogether an important acquisition to ichthyological literature in general, all the more that it deals with countries very imperfectly known until now.

The fifth fascicule of the work contains two papers by M. Alénitzin: "On the Sweet Water Springs on the Shores of Lake Aral," and a "Sketch of the History of the Islands of that Lake," the former containing some interesting information as to the distribution of water in sandy steppes.